Study of Different Shadow Detection and Removal Algorithm

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Abstract

In Remote sensing Images shadow appears mainly due to elevated objects. This shadow affect image partially or totally. Hence, Shadow detection and removal remained a challenging task. Significant research carried out on different shadow detection techniques. Although, many algorithms and methods have been developed for different environmental conditions to detect and remove shadow from the images. This paper is aimed to provide reviews on various shadow detection and removal methods and compare them critically.

Keywords

Detection Algorithm, Remote Sensing Images, Removal of the Shadow, Shadow, Shadow Detection

I. Introduction

Image processing helps advances in various real life fields such as, optical imaging (cameras, microscopes) and, medical (CT, MRI), Astronomical imaging (telescopes), video transmission (HDTV), computer vision (robots, license plate reader), commercial software’s (Photoshop), Remote sensing Field and many more. Hence, Image processing has been area of research that attracts the interest of wide variety of researchers. It deals with processing of images, video etc. with various aspects like image zooming, image segmentation, image enhancement. Detection and removal of shadow play much important and vital role in the images as well in the videos, mainly in Remote sensing field as well in the surveillance system. Hence reliable detection of shadow is very essential to remove it effectively. The problem of shadowing is normally significant in Very High-resolution satellite imaging. The shadowing effect is compounded in region where there are dramatic changes in surface elevation mostly in urban areas.

II. Overview of Shadow and its Types

A. Shadow

In image processing the image captured may consist of an area where direct light from source does not reach due to obstructions such areas are referred as shadows. [1] The shadow removal has been discussed in few studies but the image restored by existing approaches fails to perfectly restore original background patterns once shadows removed. [3]

B. Assumptions of Shadow

The following basic assumptions has been considered,
1. Illumination image is spatially smooth.
2. No change in the texture inside the shadow region.
3. The illumination image is close to being constant in shadow regions, the shadow is reflection image and pixels inside its regions have different colors. In image processing shadow detection and then its removal is an important task. [3]

C. Self and Cast Shadow

While dealing with the outdoor images the occurrence of shadow occurs when objects impede light from source though it provide rich information about the object shapes and light orientations. Some time it becomes difficult to differentiate original image of a particular object from shadow and thus reduces the reliability of many computer vision algorithms. [3] Shadow often degrades the visual quality of images. Shadow removal in an image is an important pre-processing step for computer vision algorithm and image enhancement.

III. Shadow Detection And Removal Algorithms

<table>
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<th>Method</th>
<th>Key Idea</th>
<th>Advantage</th>
<th>Disadvantage</th>
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<td>Region growing</td>
<td>Mean and standard deviation are calculated.</td>
<td>Orientation based technique</td>
<td>Region growing failed when the pixel intensity varied widely in the shadow region.</td>
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<td>Dual-pass Otsu</td>
<td>Pixels value is separated into high and low level intensity. Threshold is set to differentiate between self and cast shadow. Cast shadow pixels are replaced by background pixels.</td>
<td>It is Less Expensive method</td>
<td>Poorest Performance</td>
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Fig. 2.1 : Illustration of Cast and Self Shadows
### Method: Edge subtraction and Morphology

**Key Idea:** Canny edge detection is used to detect background and foreground edge. Resultant edge image is calculated by difference of both background and foreground edge.

**Advantage:** It gives best results when scenes containing light and dark vehicles.

**Disadvantage:** Computationally expensive method.

### Method: Gradient based background subtraction

**Key Idea:** Fixed threshold is set for $T$ vertical and $T$ horizontal boundary of object is extracted using neighboring ratio. Foreground is extracted using mixture of Gaussians.

**Advantage:** Location is used to detect the shadow. Used in Real-time application.

### Method: Pixel Intensity based approach

**Key Idea:** Standard deviation is calculated for ratio value. Conditions are set for a shadowed pixel.

**Advantage:** The probability density function for pixel intensity is estimated directly from the data without any other assumptions.

**Disadvantage:** Actually the pixel intensity value is susceptible to illumination changes.

### Method: Based on photometric invariants information

**Key Idea:** Intensities in the neighbor pixels in the foreground region are equal to the ratio of neighbor pixels in the background image in the presence of shadow.

**Advantage:** Performance is better by using robust features. The average time consumption is good for real-time application.

### Method: Partial Differential Equations

**Key Idea:** Different filters are used to smooth the image. Gradient vector is used to detect shadow. Image information is used.

**Advantage:** Effective shadow detection achieved using this method.

### Method: Illumination Assessment Method

**Key Idea:** Presence of shadow in object is confirmed by illumination assessment method.

**Advantage:** It takes less processing time.

**Disadvantage:** Only foreground figure is considered to examine presence of shadow. This method cannot be applied for all kinds of applications.

### Method: Hierarchical Graph cut

**Key Idea:** Image is over segmented to produces the set of super pixels, lazy snapping is used to specify shadow, Non-shadow and background region.

**Advantage:** It solves multi-labeling problems. Image restoration, shadow removal and stereo matching are done by hierarchical graph cut algorithm.

**Disadvantage:** An initial value is required. Single image is considered to remove the shadow.

### Method: Adaboost Classifiers in a co-training Framework

**Key Idea:** Accuracy comparison is calculated by finding shadow detection rate and shadow discrimination accuracy.

**Advantage:** Algorithm is feasible and effective for indoor and outdoor scene.

**Disadvantage:** Lack of good partition about the features.

### Method: Susan Algorithm

**Key Idea:** Video highway data with avi format, Edge is detected from Susan method.

**Advantage:** Speed is enhanced. Method is simple, Convenient, Low complexity. It gives good detection effect.

**Disadvantage:** Less Efficient than Harris Algorithm

### Method: Harris Algorithm

**Key Idea:** Neighboring point eliminating method used to detect corner efficiently.

**Advantage:** More efficient than Susan algorithm. It avoids clustering.

### Method: Support Vector Machine Method

**Key Idea:** It implements mapping of the inputs on to the high dimensional space using nonlinear basis function. It is Mainly used for binary classification of the image which contain shadow.

**Advantage:** It is a classifier so it’s a best tool to differentiate shadow and non-shadow part. It gives the better accuracy than other methods.

**Disadvantage:** Advanced kernel functions required.

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From Table I, For Shadow detection and removal in various applications, different methods and different algorithm gives different results. Shadow removal from traffic images [1], gives three methods. First method attempts to remove shadows by using Otsu method. Pixels value is separated into high and low level intensity, threshold is set to distinguish between self and cast shadow, cast shadow pixels are then replaced by background pixels. But this method shows inadequate performance than region growing and edge subtractions and morphology. Region growing fails when in the shadow region the pixel intensity varied widely. When scenes contain light and dark vehicles, Edge subtractions and morphology Algorithm is used. Gradient-based background subtraction [2], method used in shadow detection for moving humans cast shadow and is removed without affecting
self-shadow. This method is used in real time applications. In the image to confirm the presence of shadow the Illumination assessment method [3] can be used. In this method, traffic images are taken with stationary cameras. This method is also applicable for real time applications. One other method for shadow detection is Adaboost classifiers [4] in this method, labeled data sets are taken with weak classifiers and converted into strong classifiers. White area indicate foreground and gray pixel signifies shadow, 320*240 pixel image is taken, black region means background, accuracy comparison is calculated by finding shadow detection rate and shadow discrimination accuracy. This Algorithm is viable and efficient for indoor as well outdoor scene. To remove shadow from a particular image hierarchical graph cut [5] method can be used. This method solves multi-label MRF problems. Intelligent transportation system may face this problem of moving shadow; to remove shadow from the moving object is another challenging task. Susan algorithm [6], used in detection of shadow in the videos which are in .avi format using this method the Speed is enhanced. This method is simple, Convenient, Low complexity. It gives good detection effect but Harris algorithm [7], gives best result than Susan algorithm of corner detection. A relative study on the shadow detection methods [8], based on Intensity information, based on photometric invariants information, method gray-scale pixel intensity value in the presence of illumination changes fails to detect shadow region accurately. Actually the pixel intensity value is susceptible to illumination changes. Partial differential equations used to detect shadow in urban color aerial images [9]. Different filters are used to smooth the image; gradient vector is used to detect shadow. Hence, Shadow detection is done effectively done by this method for urban Aerial images. SVM method is useful during mapping of the input data onto a high dimensional space with the help of nonlinear basis function. SVM used for binary classification of VHR images. It is a best tool to differentiate shadow and non shadow part. It gives the better accuracy than any other methods.

IV. Result
In our proposed method we use SVM Classifier for binary classification of VHR image. The image acquired by IKONOS-2. We applied binary mask and post processed mask on the original image. Then multiclass classification with SVM classifier is used to obtain the appropriate result.

The expected results of our proposed method:

Fig. 2.2 : Original image with the presence of shadow

Fig. 2.3 : Result of Multiclass classification

V. Conclusion
In this paper, first the basics of the shadow, how shadow occurs, then different types of shadows are mentioned which can appear in the images. Secondly, comparative survey for analyzing different shadow detection and removal methods is done. After analysis we like to conclude that; there is no ‘the best Algorithm/method/classifier’. The choice of the best Algorithm/method/classifier is depend on data-set characteristics which being processed. For any application, a particular classifier which performs very well it may also give poor performance in a different setting. As well the cost plays important role while selecting the algorithm.

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